Land Surface Temperature EDR for the U.S. GOES-R and JPSS Mission

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Introduction

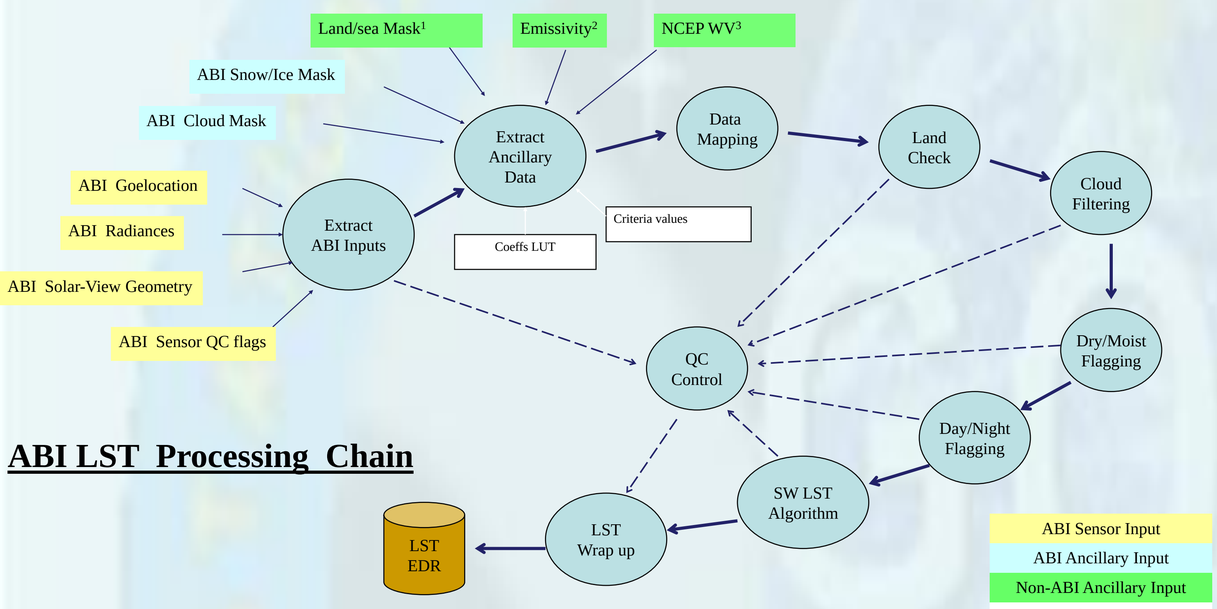
Development of land surface temperature (LST) Environmental Data Record (EDR) for the U.S. Geostationary Operational Environmental Satellite (GOES) R series (GOES-R) satellite mission and the Joint Polar-orbiting Satellite System mission has been conducted since 2006 at the U.S. National Oceanic and Atmospheric Administration (NOAA) center for SaTellite Applications and Research center (STAR). Currently the NPP satellite, which is a preparation satellite for the JPSS mission, has been on orbit since October 2011; while the GOES-R satellite will be launched in 2016. LST EDRs are/will be produced from Visible Infrared Imager Radiometer Suite (VIIRS) onboard NPP/JPSS satellites and Advanced Baseline Imager (ABI) on board GOES-R satellite. The VIIRS LST product is under intensive testing, while the ABI LST algorithm has been developed and tested using proxy data

GOES-R ABI LST Generation

A regression split window algorithm has been applied to generate GOES-R LST product using brightness temperature data (T_{11} and T_{12}) at channels *11 μm* and *12 μm*, respectively. Mean emissivity (ε) of the two channels is utilized explicitly in the algorithm. Proxy data sources used for testing include EOS/MODIS, current GOES/Imager and MSG/SEVIRI.

Current status: 100% readiness ATBD and software package is done; tested using proxy and ground data; validation tools are in development.

Algorithm : $T_s = C + A_1 T_{11} + A_2 (T_{11} - T_{12}) + A_3 \varepsilon + D(T_{11} - T_{12})(\sec\theta - 1)$



ABI LST Processing Chain

JPSS VIIRS LST Generation

Dual-Split Window (DSW) and Split Window (SW) algorithms have been applied to generate JPSS VIIRS LST product. In addition to the brightness temperatures (T_{11} and T_{12}) at channels *11 μm* and *12 μm*, the DSW algorithm also uses brightness temperatures at channels 3.75 *μm* and 4.0 *μm*. Algorithm coefficients are clarified with 17 IGBP surface types for counting the surface emissivity dependency. The DWS also applies different formula for daytime and nighttime scenario.

Current status: NPP was launched in October 2011; DSW is in operation since then; SW will be swathed on by July 2012 to replace DWS, with updated algorithm coefficients; Evaluation is in performance using MODIS and ground LST estimations.

Algorithm :

SW algorithm

$$T_{s,i} = a_{0,i} + a_{1,i} T_{11} + a_{2,i} (T_{11} - T_{12}) + a_{3,i} (\sec\theta - 1) + a_{4,i} (T_{11} - T_{12})^2$$

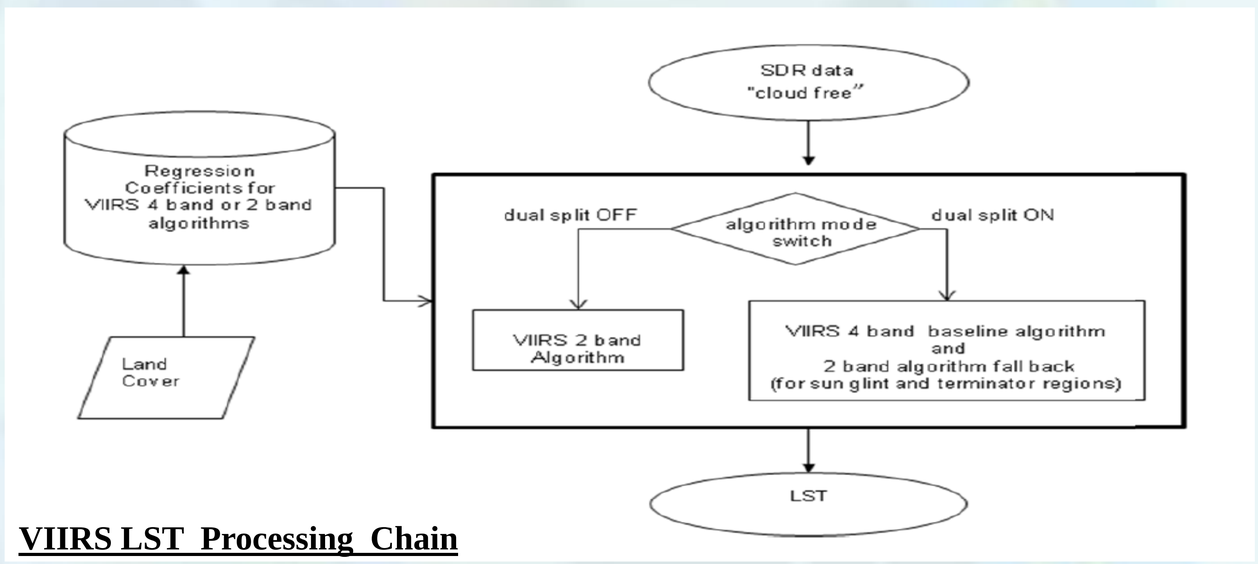
Daytime DSW algorithm

$$T_{s,i} = a_{0,i} + a_{1,i} T_{11} + a_{2,i} (T_{11} - T_{12}) + a_{3,i} (\sec\theta - 1) + a_{4,i} T_{3.75} + a_{5,i} T_{4.0} + a_{6,i} T_{3.75} \cos\phi + a_{7,i} T_{4.0} \cos\phi + a_{8,i} (T_{11} - T_{12})^2$$

Nighttime DSW algorithm

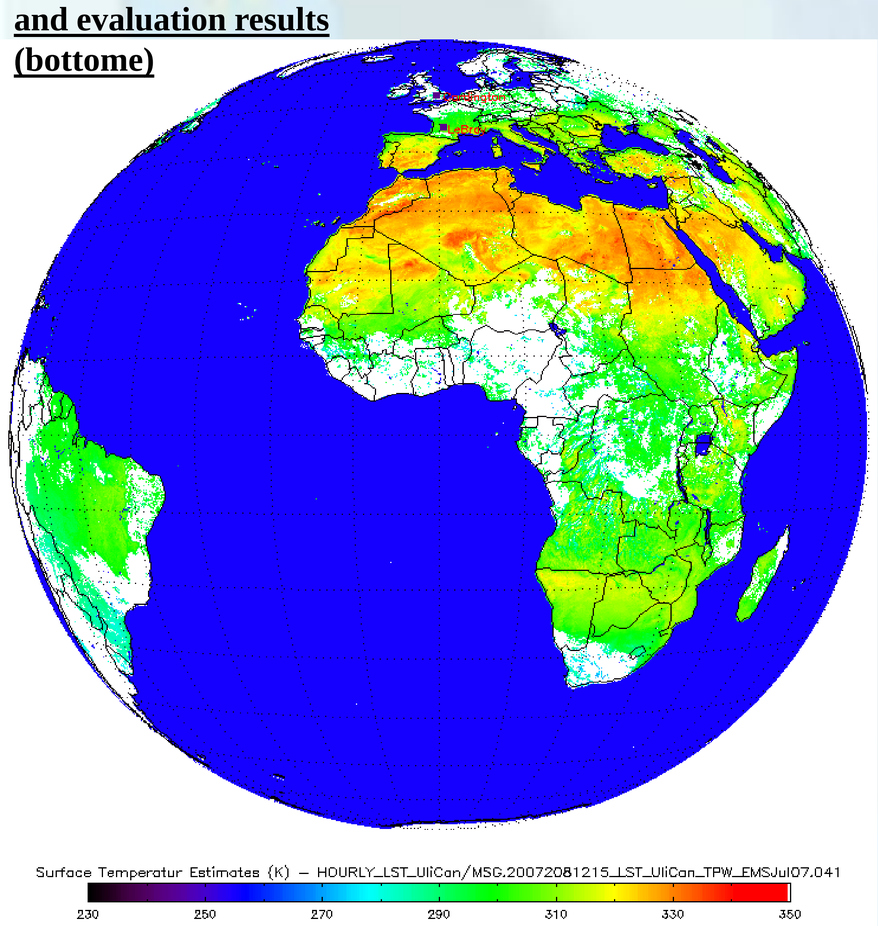
$$T_{s,i} = a_{0,i} + a_{1,i} T_{11} + a_{2,i} (T_{11} - T_{12}) + a_{3,i} (\sec\theta - 1) + a_{4,i} T_{3.75} + a_{5,i} T_{4.0} + a_{6,i} T_{3.75}^2 + a_{7,i} T_{4.0}^2 + a_{8,i} (T_{11} - T_{12})^2$$

Note: $a_{k,i}$ are algorithm coefficients; i indicates 17 IGBP surface types; θ is view zenith angle, ϕ is solar zenith angle.

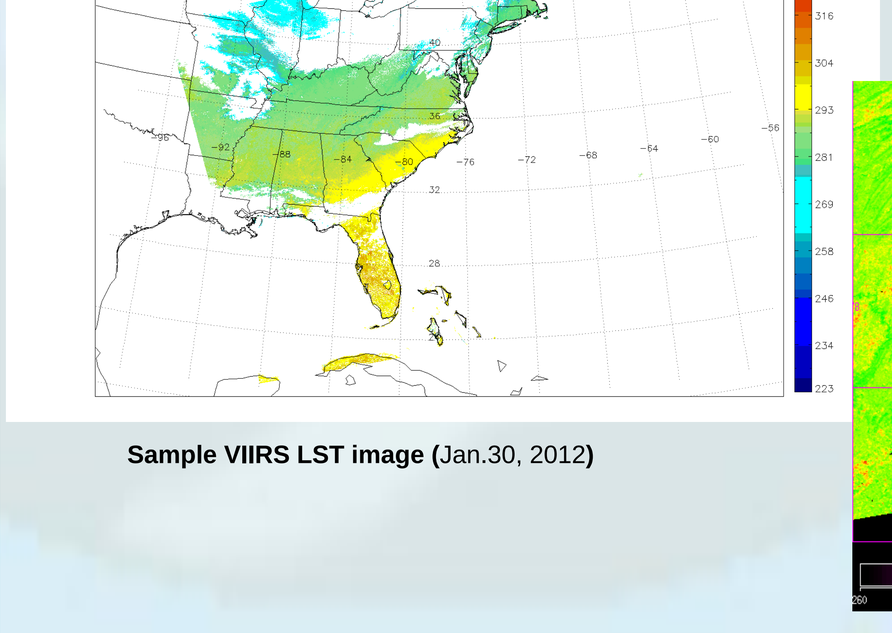


VIIRS LST Processing Chain

Sample LST image (left), and evaluation results (bottome)

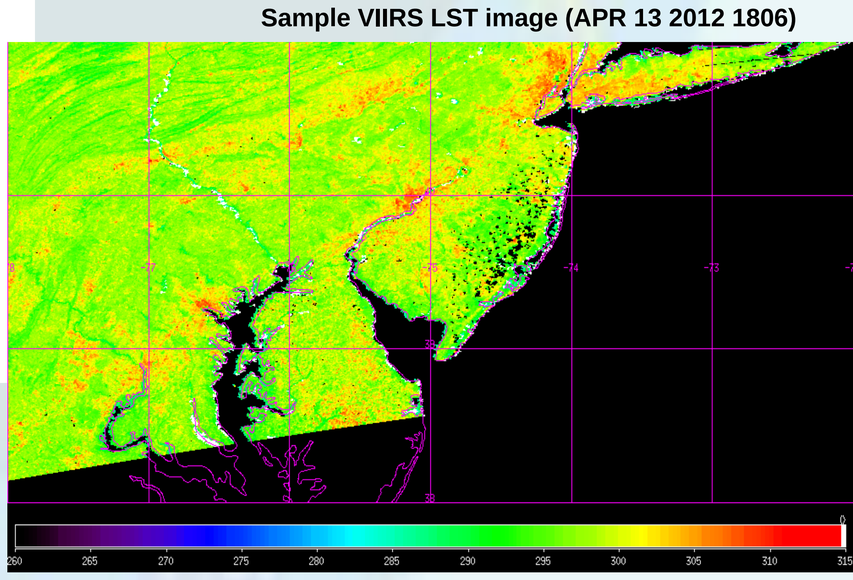


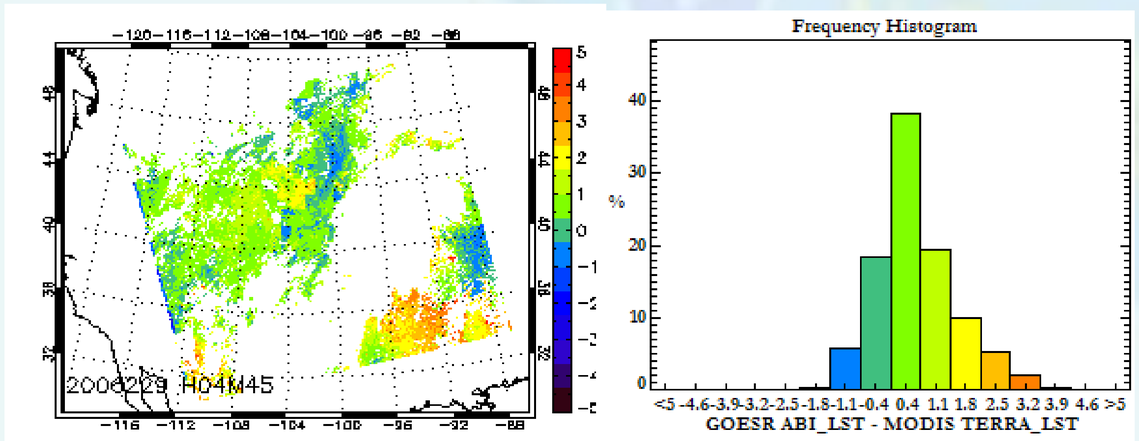
ABI LST tested using SEVIRI data at 12:15 UTC, July 27, 2007.



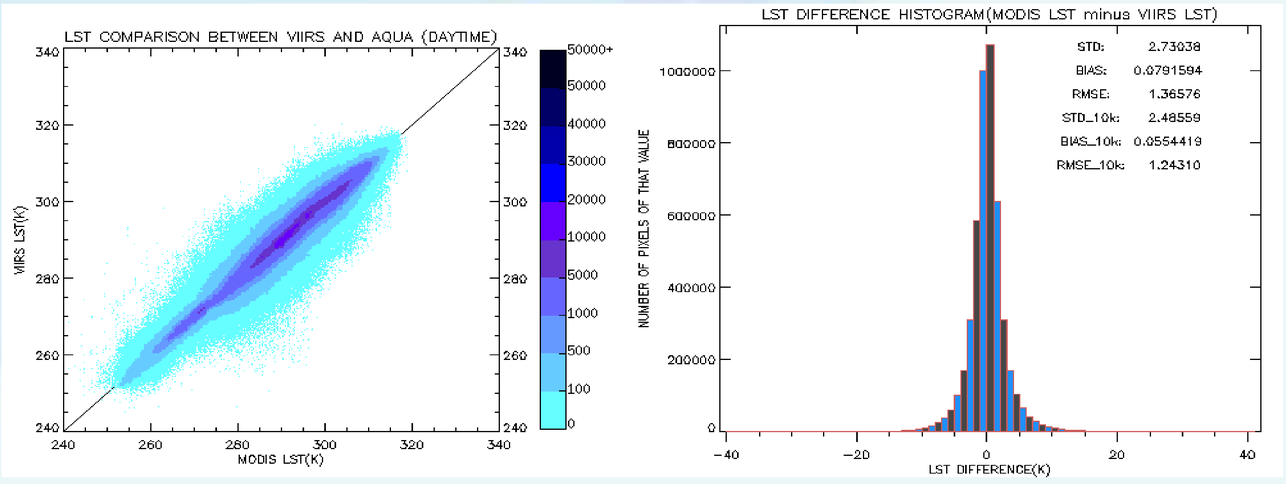
Sample VIIRS LST image (Jan.30, 2012**)**

Sample VIIRS LST image (APR 13 2012 1806)





Validation sample: Image and histogram plot of LST difference between the proxy GOES-R LST and the MODIS LST. The data is sampled from MODIS Terra, on August 17, 2006



Daytime comparison between the VIIRS LST and AQUA LST. Scatter plots of the two LSTs are shown on the left; the color bar represents the density of LST pairs in each bin (0.5K). Histogram of the difference is shown on the right with the standard deviation (STD), bias and the root mean square error (RMSE); STD_10K, BIAS_10K and RMSE_10K represent results after removing those suspicious data in which the difference between the VIIRS LST and the MODIS LST is greater than 10K